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Characterization Analysis Report Surface Vessel Bilgewater/Oil Water Separator

Section 8.0 – LSD 41 Class: Vessels Compression Ignition Engines in the Whidbey Island Class

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SECTION 8.0 – LSD 41 CLASS

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8.0 LSD 41 CLASS

The USS WHIDBEY ISLAND Class (LSD 41) was selected to represent the group of large vessels that rely on compression ignition engines for main propulsion. The LSD 41 vessel class, if combined with the USS Harpers Ferry Class LSD 49 (also known as the LSD 41 variant), is one of the newest and largest classes (12 hulls) in the group. The class is also evenly distributed between the Pacific and Atlantic fleets. This chapter presents the physical parameters, chemical data, field data, descriptive information, and generation rates for the LSD 41 Class vessels.

For large compression ignition engine vessels, water from the oily waste collection tanks drains or is pumped into the oily waste holding tank (OWHT). Aboard LSD 41 Class vessels there are two separate OWHTs (one forward and one aft). Once in the OWHT, bilgewater is processed by one or both of the ship's oil water separators (OWS). The OWS influent is a mixture of bilgewater from the various bilge areas. Sampling was conducted aboard two ships in this group, USS OAK HILL (LSD 51) and USS RUSHMORE (LSD 47). Sampling occurred on USS OAK HILL (LSD 51) on November 16-17, 1999 and on USS RUSHMORE (LSD 47) on September 26, October 17, November 17 and December 13, 2000.

The primary OWS system currently installed onboard LSD 41 Class vessels includes two parallel-plate 10-gpm gravity coalescence type oil-water separators for processing bilgewater. These vessels typically process bilgewater both pierside and underway, discharging the processed effluent into the surrounding waters. The processing needs of the ship within 12 nm are generally met through the use of one 10-gpm system.

The following summarizes the general vessel characteristics for the LSD 41 Class vessels.

<u>General Vessel Characteristics (Navy, 2001a)</u>

Draft (ft):	20
Length at waterline (ft):	580
Beam at waterline (ft):	84
Displacement (tons):	16,360

8.1 BASELINE DISCHARGE

The baseline discharge is defined as the direct discharge of the bilgewater collected in the OWHT. This discharge is assumed to occur at the normal OWS flow rate while bypassing the OWS. It is important to note that although the term baseline discharge is used for this report, Armed Forces vessels do not discharge bilgewater from the OWHT directly overboard without treatment. This scenario is included in the Uniform National Discharge Standards (UNDS) analysis only to establish a reference point for subsequent comparisons. The baseline analysis will be based on discharging the entire volume of untreated bilgewater overboard at 10 gpm through a single OWS system discharge port.

8.1.1 Characterization Data

Sources of bilgewater aboard the LSD 41 Class vessels include liquid that drains from the interior spaces and upper decks into the bilge or lowest inner part of the vessel's hull (Navy, 2001a). Sources of bilgewater can be found in the main engine rooms, auxiliary machinery rooms, shaft alley, steering gear rooms, pump rooms, air conditioning and refrigeration machinery rooms, and oil laboratories. The liquid phase of this fluid may contain oily constituents including DFM (emergency diesel generators), JP-5 fuel (main gas turbine engines and aircraft), 2190TEP lube oil (auxiliary equipment), 9250 lube oil (emergency diesel generators), synthetic lube oil (main engines and aircraft engines), hydraulic oil (elevators, cranes, and winches), and various grades of grease lubricants used on pulleys, cables, valves, and other components which may have dripped directly into bilge spaces, or other ship spaces communicating with the bilge. Additional potential bilge constituents include dissolved metals and metal-containing particulate matter.

8.1.1.1 Physical Parameters

The physical parameters presented in this section include values necessary for hydrodynamic modeling of the discharge, which differs from shipboard data. The characteristics of the LSD 41 baseline discharge (Table 8-1) were developed using the assumption that bilgewater is discharged overboard at the OWS design flow rate(s) while bypassing the OWS.

There are two potential modeling scenarios associated with the baseline and marine pollution control device (MPCD) discharges. Scenario 1 assumes the discharge of all of the bilgewater through the discharge port located on the starboard side of the ship; scenario 2 assumes the discharge of all of the bilgewater through the discharge port located on the port side of the ship. Because the two oily waste transfer and treatment systems are cross-connected on the suction side, the ship has the capability to process all of its oily waste through either OWS.

Table 8-1. Discharge Characteristics for LSD 41 Baseline

Modeling Parameters	Values	
Option Group	**Baseline Scenario 1**	**Baseline Scenario 2**
Vertical (feet)	+2	+3.5
Transverse (feet)	-42	+42
Length (feet)	190	380
Diameter (inches)	2	2
Temperature (°C)	25	25
Salinity (ppt)	7.7	7.7
Flow (gpm)	10	10
Velocity (ft/sec)	1	1
Duration of Release Event (hr)	11.7	11.7
Time Between Release Events (hr)	44.5	44.5

Vertical – Approximate distance from waterline to discharge port (+, above, -, below)
Transverse – Distance from centerline to discharge port (+, port, -, starboard)
Length – Approximate distance from forward perpendicular to discharge port
Diameter – Diameter of discharge port
ppt – parts per thousand
gpm – gallons per minute
ft/sec – feet per second
hr – hour
°C – Degree Celsius

The influent of the OWS is characterized in this report as the baseline from which a relative analysis of the MPCD options can be performed. The parameters for the engineering and modeling recommendation summary are based on the specifications in LSD 41 installation drawings of the OWS and a ship check.

Several parameters were identified for the discharge port on the LSD 41. These parameters include: discharge port location in relation to the waterline (vertical), distance from the centerline to discharge port (transverse), approximate distance from forward perpendicular to discharge port (length), and discharge port diameter (diameter) (Meade, 2001b). Additional discharge characteristics identified for modeling purposes include temperature, salinity, flow rate, discharge velocity, duration of release event, and time between release events.

The temperature of bilgewater is dependent on several factors. Bilgewater on a LSD 41 Class vessel is temporarily held in the ship's bilge or in an OWHT. Consequently, ambient air temperature inside the machinery space and the temperature of the source bilgewater can have an effect on bilgewater temperature. However, because the bilge and OWHT are separated from the waterbody only by the ship's hull, bilgewater is often at or near the ambient water temperature. Because bilgewater is not used as a cooling or heating fluid and there is ample opportunity for thermal equilibration (heat transfer through the metal hull), bilgewater is assumed to be at the temperature of the receiving water. Furthermore, for modeling purposes, the ambient water temperature is assumed to be 25º C.

Unlike other parameters used for modeling purposes, sampling data from the OWS influent were used to determine the salinity value for LSD 41 baseline discharge (Navy, 2000f and 2001e). To facilitate obtaining a representative salinity value, an average of the sample results was used to determine one representative salinity value for the baseline discharge (the same value is used for subsequent analysis of the primary treatment MPCD; see Section 8.2.1.1).

Of the remaining discharge characteristics required for modeling, flow, velocity, and duration of release event are interdependent. The exit velocity of the discharge port is equal to flow rate divided by the cross-sectional area of the discharge pipe (velocity = flow/area). The flow rate for the baseline is the rated capacity of the MPCD (i.e., 10 gpm for the gravity coalescer). The area is calculated from the diameter of the discharge pipe. The duration of the release event is based on the size of the OWHT, the rated capacity of any control in place, and the bilgewater generation rate. The volume of bilgewater being processed is based upon Navy practices, which assumes processing begins when the OWHT reaches 90 percent capacity (Smith, B., 2001). The duration is calculated as follows:

Duration of Release = (0.90 * OWHT Volume) / (Rated MPCD Capacity – Bilgewater Generation Rate)

The time between release events is determined using bilgewater generation rate data and OWHT capacities. Again, for purposes of modeling, it is assumed that the entire discharge release/non-release cycle (a release event followed by the time between release events) occurs while the vessel is pierside. The formulas used to determine some of the values in the physical parameters section are presented in Appendix A.

8.1.1.2 Constituent Data, Classical Data, and Other Descriptors

Chemical Data

During UNDS Phase II, sampling was conducted aboard two vessels of the LSD 41 Class, USS OAK HILL (16-17 November), and USS RUSHMORE (26 September 2000, 17 October 2000, 17 November 2000, and 13 December 2000). These two sampling episodes serve as the primary sources of chemical data for this vessel group.

The samples were analyzed by Ecology and Environment, Inc., Pacific Analytical, Inc., Columbia Analytical Services (through Pacific Analytical, Inc.) and Q Biochem laboratories (formally ETS Analytical Services, Inc.). The results were reviewed by EPA and DoD to determine the quality of the analytical data; however some sample data were excluded from the final calculations, as documented in the *Draft Sampling Episode Report – USS RUSHMORE* (Navy, 2001c) and *Draft Sampling Episode Report – USS OAK HILL* (Navy, 2000f), based upon Sample Control Center (SCC) review. Data quality was considered for all analyses conducted. To ensure data quality after reviewing documented matrix spike failures and process information discrepancies, a confirmation analysis was conducted for pesticides. This confirmation analysis revealed that there were no pesticides present in the reanalyzed samples. As a result, pesticides are not included in bilgewater discharge profiles (Navy and EPA, 2002).

SCC-validated data include the constituents present in the waste stream and their concentrations. Sampling was conducted on the OWS influent, which was considered the untreated baseline for this vessel group. Several methods used for analyses during Phase I are different from those used for Phase II analyses. For example, mercury was analyzed by EPA Method 1631 for Phase I, but for Phase II samples, EPA Method 1620 was used. The primary difference between these methods is that Method 1631 has a much lower detection limit than Method 1620. The decision to use Method 1620 in place of Method 1631 was due to the susceptibility of Method 1631 to a variety of matrix interferences stemming from liquids released from machinery room equipment. After reviewing Phase I analytical data, EPA Method 1620, with the higher detection level, was found to be suitable for Phase II because constituents were found in sufficiently high concentrations such that the cost of using more sensitive and expensive techniques was unjustified. The sampling and analytical decisions made for samples collected on LSD 47 are detailed in the Sampling and Analysis Plan (SAP). Four field samples were taken during each sampling episode from the influent (representing the baseline) to the OWS. For more information, see the *Sampling Episode Report – USS RUSHMORE* (Navy, 2001c) and *Sampling Episode Report – USS OAK HILL* (Navy, 2000f).

Constituent concentrations are represented by the geometric mean of the measured concentrations in the influent samples. See Appendix G for final constituent values.

Field Information

Field information refers to data obtained at the time of sample collection. The field tests that were conducted on LSD 47 AND LSD 51 included pH, temperature, salinity, specific conductance, and free and total chlorine. For these field tests, the reported value was determined by calculating an average of all field measurements. Table 8-2 lists the values for each parameter.

Table 8-2. Field Testing Parameters for LSD 41 Baseline

Field Parameter	Values
pH	7.1
Temperature	20 ºC
Salinity	8.0 ppt
Specific Conductance	14,000 µS/cm
Free Chlorine	0.03 mg/L
Total Chlorine	0.04 mg/L

Descriptive Information

Descriptive information refers to data collected to facilitate the environmental effects analysis and is presented here to give a more complete description of the discharge. This information included observations or measurements of colloidal matter, color, floating material, foam, odor, scum, settleable materials, taste, total dissolved gases, and turbidity. For the parameters where the results were based on observation, the value was reported from these samples. Specifically, color and odor determinations were made using these samples. For the parameters where the results were based on field tests, an average was used as the parameter value except for the total dissolved gases parameter. For this parameter, the lowest dissolved oxygen (DO) value was reported in the profile report and used in the environmental effects analysis, because lower DO values are a greater environmental concern. Table 8-3 lists the values for the descriptive data.

Table 8-3. Descriptive Discharge Profile for LSD 41 Baseline

Narrative Parameter	Field Observations
Color	Yellow, 66 Color Units
Floating Materials	Not observed in most samples collected
Foam	None observed in samples collected
Odor	Oil/ fuel smell
Scum	None observed in samples collected
Settleable Materials	None observed in samples collected
Total Dissolved Gases	DO 1.90 mg/L, no other gases were measured
Turbidity/Colloidal Matter	34 NTU/ No

8.1.1.3 Discharge Generation Rates for Mass Loading

Vessels in the LSD 41 vessel group are stationed in saltwater ports and do not operate in freshwater. Daily generation rates were obtained from previously reported underway surveys (Navy, 1997a and 1995), which assume that in-port generation rates are approximately 25 percent of the underway generation rates. The annual discharge volumes are derived in Table 8-4 by multiplying these reported values by the average number of days that the class spends in port or at sea.

Table 8-4. LSD 41 Vessel Group Generation Volumes

Class[1]	Number of Vessels	Days in Port	Days Underway (0-12 nm)	Days Underway (12+ nm)	Daily generation rate per vessel (gal/day)			Annual generation rate per class (gal/year)		
					In Port	Underway (0-12 nm)	Underway (12+ nm)	In Port	Underway (0-12 nm)	Underway (12+ nm)
LPD 17	12	172	10	183	3.3E+03	1.3E+04	1.3E+04	6.7E+06	1.6E+06	2.9E+07
LSD 41	8	170	5	190	2.5E+03	1.0E+04	1.0E+04	3.4E+06	4.0E+05	1.5E+07
LSD 49	4	190	54	170	2.5E+03	1.0E+04	1.0E+04	1.9E+06	2.2E+06	6.8E+06
T-AFS 8	3	245	20	100	7.0E+02	2.8E+03	2.8E+03	5.1E+05	1.7E+05	8.4E+05
T-AKR 295	4	295	20	50	3.3E+03	1.3E+04	1.3E+04	3.9E+06	1.1E+06	2.6E+06
T-AKR 300	7	295	20	50	7.1E+03	2.8E+04	2.8E+04	1.5E+07	4.0E+06	9.9E+06
T-AGS	1	245	20	100	1.9E+03	7.6E+03	7.6E+03	4.7E+05	1.5E+05	7.6E+05
T-AO 187	14	295	20	50	1.6E+03	6.4E+03	6.4E+03	5.5E+06	1.8E+06	4.5E+06
T-ARC 7	1	245	20	100	2.1E+03	8.4E+03	8.4E+03	5.1E+05	1.7E+05	8.4E+05
WAGB 420	1	121	101	115	2.5E+02	1.0E+03	1.0E+03	3.0E+04	1.0E+05	1.2E+05
Total	55	-	-	-	2.5E+04	1.0E+05	1.0E+05	3.9E+07	1.1E+07	7.0E+07

[1] Due to some vessels being removed from the water, the number of days in port, Underway 0-12 nm, and Underway 12+ nm may not total 365 days.

8.2 PRIMARY TREATMENT

Gravity coalescer represents the currently installed primary treatment MPCD onboard LSD 41 Class vessels. Most ships of the LSD 41 Class currently have two 10-gpm systems with discharge locations that are cross-connected on the suction side, thus allowing the ship the capability to process all of its oily waste through one OWS. Because only one OWS is normally used within 12 nm, subsequent analyses are based on one of the two 10-gpm systems processing the entire volume of bilgewater. Primary treatment creates two waste streams: the aqueous fraction, which is discharged overboard, and the oil fraction, which is directed to the onboard waste oil holding tank. The characterization of the aqueous fraction is described below. The oil fraction is subject to collection, holding and transfer (CHT), treatment at a properly permitted facility, and applicable Federal, State, and local disposal regulations.

8.2.1 Characterization Data

Characterization data are comprised of physical parameters, chemical data, field data, and descriptive information. Each of these parameters is discussed below. See Section 8.1.1 for identification of possible bilgewater sources.

8.2.1.1 Physical Parameters

The physical parameters include values necessary for hydrodynamic modeling of the discharge, which differs from shipboard data. The characteristics for the LSD 41 discharge (Table 8-5) were developed using the assumption that bilgewater is discharged overboard at the OWS design flow rate(s) while bypassing the OWS.

Table 8-5. Discharge Characteristics for LSD 41 Primary Treatment

Modeling Parameters	Values	
Option Group	Primary Treatment Scenario 1	Primary Treatment Scenario 2
Vertical (feet)	+2	+3.5
Transverse (feet)	-42	+42
Length (feet)	190	380
Diameter (inches)	2	2
Temperature (°C)	25	25
Salinity (ppt)	7.7	7.7
Flow (gpm)	10	10
Velocity (ft/sec)	1	1
Duration of Release Event (hr)	11.7	11.7
Time Between Release Events (hr)	44.5	44.5

Vertical – Approximate distance from waterline to discharge port (+, above, -, below)
Transverse – Distance from centerline to discharge port (+, port, -, starboard)
Length – Approximate distance from forward perpendicular to discharge port
Diameter – Diameter of discharge port
ppt – parts per thousand
gpm – gallons per minute
ft/sec – feet per second
hr – hour
°C – Degree Celsius

The formulas used to determine some of the values in the physical parameters section are presented in Appendix A.

8.2.1.2 Constituent Data, Classical Data, and Other Descriptors

Chemical Data

Sampling was conducted on two LSD 41 Class vessels, USS OAK HILL (LSD 51) and USS RUSHMORE (LSD 47), and serves as the primary sources of chemical data for this vessel group. The samples from this ship were taken prior to and following the gravity coalescer. Constituent concentrations are represented as the geometric mean of the measured concentrations in the effluent samples. Some analytical data were excluded, as documented in the SER, based upon SCC review of the data. See Appendix F for final constituent values.

Field Information

Field information refers to data obtained at the time of sample collection. Field tests conducted on the gravity coalescer samples from the LSD 41 included pH, temperature, salinity, specific conductance, and free and total chlorine. For these field tests, the reported value was determined by calculating an average of all field measurements. Table 8-6 lists the values for each parameter.

Table 8-6. Field Testing for LSD 41 Primary Treatment

Field Parameter	Values
pH	6.9
Temperature	16.1 °C
Salinity	7.4 ppt
Specific Conductance	13,000 µS/cm
Free Chlorine	0.04 mg/L
Total Chlorine	0.04 mg/L

Descriptive Information

Descriptive observations and tests were conducted on the MPCD gravity coalescer effluent samples from the LSD 47. This information included observations or measurements of colloidal matter, color, floating material, foam, odor, scum, settleable materials, taste, total dissolved gases, and turbidity. For parameters based on observations (color and odor), the reported determinations were based upon these samples. For the parameters based on measurements, an average was used as the reported value except for the total dissolved gases parameter. For this parameter, the lowest DO value was reported in the profile report and used in the environmental effects analysis, because lower DO values are a greater environmental concern. Table 8-7 lists the values for the descriptive data.

Table 8-7. Descriptive Discharge Profile for LSD 41 Primary Treatment

Narrative Parameter	Field Observations
Color	Variable: ½ clear and ½ yellow
Floating Materials	None observed in most samples collected
Foam	None observed in samples collected
Odor	Oil/Fuel smell
Scum	None observed in samples collected
Settleable Materials	None observed in samples collected
Total Dissolved Gases	DO 0.40 mg/L, no other gases were measured
Turbidity/Colloidal Matter	33 NTU/No

8.2.1.3 Discharge Generation Rates for Mass Loading

The use of a primary treatment MPCD does not affect the generation rate of bilgewater; therefore, the baseline generation and annual volume data are used for the annual discharge volume for this MPCD treatment system. It is assumed that the volume change due to the removal of oil by the treatment device is negligible. See Table 8-4, Section 8.1.1.3, for the baseline generation volumes.

8.3 PRIMARY TREATMENT PLUS FILTER MEDIA

This MPCD option involves treatment with a primary treatment MPCD followed by a secondary treatment through filter media. Primary treatment plus filter media creates two waste streams: the aqueous fraction, which is discharged overboard, and the oil fraction, which is directed to the onboard waste oil holding tank. After initial treatment by the OWS, the aqueous waste stream is either re-directed back to the OWHT for reprocessing or sent to the polisher (i.e., filter media) system. This is controlled by monitoring the waste stream oil concentration with an oil content monitor (OCM). For concentrations greater than 200 ppm, the waste stream is returned to the OWHT for re-circulation through the OWS, whereas for oil concentrations less than 200 ppm, the waste stream is sent on to the filter media system (Navy, 2001d). The filter media discharge is also monitored. Effluent with oil concentration less than 15 ppm, is released overboard while wastewater with a greater than 15 ppm, it is returned to the OWHT for additional processing (Navy, 2001d). The oil fraction is subject to CHT treatment at a properly-permitted facility and applicable Federal, State, and local disposal regulations.

The characterization of the aqueous fraction is described below.

8.3.1 Characterization Data

Characterization data are comprised of physical parameters, chemical data, field data, and descriptive information. Each of these parameters is discussed below. See Section 8.1.1 for identification of possible bilgewater sources.

8.3.1.1 Physical Parameters

The physical parameters used for hydrodynamic modeling purposes, as detailed in Section 8.1.1.1, are not affected by the addition of primary and secondary MPCDs. Table 8-8 summarizes the parameters identified for modeling purposes.

Table 8-8. Discharge Characteristics for LSD 41 Primary Treatment plus Filter Media

Modeling Parameters	Values	
Option Group	**Primary Treatment plus Filter Media Scenario 1**	**Primary Treatment plus Filter Media Scenario 2**
Vertical (feet)	+2	+3.5
Transverse (feet)	-42	+42
Length (feet)	190	380
Diameter (inches)	2	2
Temperature (°C)	25	25
Salinity (ppt)	7.7	7.7
Flow (gpm)	10	10
Velocity (ft/sec)	1	1
Duration of Release Event (hr)	11.7	11.7
Time Between Release Events (hr)	44.5	44.5

Vertical – Approximate distance from waterline to discharge port (+, above, -, below)
Transverse – Distance from centerline to discharge port (+, port, -, starboard)
Length – Approximate distance from forward perpendicular to discharge port
Diameter – Diameter of discharge port
ppt – parts per thousand
gpm – gallons per minute
ft/sec – feet per second
hr – hour
°C – Degree Celsius

The formulas used to determine some of the values in the physical parameters section are presented in Appendix A.

8.3.1.2 Constituent Data, Classical Data, and Other Descriptors

Chemical Data

Using bilgewater effluent data, Naval Surface Warfare Center Carderock Division (NSWCCD) evaluated the treatment capabilities for filter media. The filter media MPCD is comprised of an oleophilic blend of granular polymer and carbon media. Although the polymer was designed to remove oil by entrainment and sorption, the carbon media will also reduce the concentrations of semi-volatile organic constituents, especially polynuclear aromatic hydrocarbons (PAHs) (Putnam and Singerman, 2001). Table 8-9 contains the treatment capabilities detailed within the NSWCCD report for filter media and the necessary calculations for the primary treatment MPCD constituents.

Table 8-9. Treatment Capabilities of Filter Media (Putnam and Singerman, 2001)

Analyte Class	Empirical Formulas for Constituent Concentrations
Classical	Ammonia as Nitrogen = C_i Nitrite/Nitrate = $0.6C_i$ Oil & Grease (HEM) = $0.3C_i$ TPH (SGT-HEM) = $0.3C_i$ Total Sulfide = $0.2C_i$ TSS = $0.43C_i$
Total Metals	Copper = $0.5M_t$ Iron = $0.4M_t$ Nickel = $0.75M_t$ Zinc = $0.6M_t$ All others = M_t
Semi-Volatile Organics	= $0.4C_i$
Volatile Organics	Chlorobenzene = $0.20C_i$ m+p-Xylene = $0.20C_i$

C_i is the concentration of the contaminant in the input stream.
M_t is the total concentration of the metal in the input stream.

Applying these treatment capabilities of filter media to the final results for the constituents of the OWS effluent produces the constituent concentrations expected by incorporating filter media (Table 8-10). See Appendix F for complete list of constituent values.

Table 8-10. Calculated Constituent Concentrations for LSD 41 – Primary Treatment Plus Filter Media

Contaminant	CAS Number	Primary Treatment	Data Qualifier	Estimated Concentration Primary Treatment Plus Filter Media	Data Qualifier
Classical (mg/L)					
Alkalinity	T005	2.1E+02		2.1E+02	
Ammonia as Nitrogen	7664417	1.6E+00		1.6E+00	
Biochemical Oxygen Demand (BOD)	C003	2.9E+01		2.9E+01	
Chemical Oxygen Demand (COD)	C004	3.8E+02		3.8E+02	
Chloride	16887006	4.4E+03		4.4E+03	
Nitrate/Nitrite	C005	3.2E+00		1.9E+00	
Oil and Grease (as HEM)	C036	2.2E+01		6.5E+00	
SGT-HEM	C037	1.0E+01		5.0E+00	U
Sulfate	14808798	4.5E+02		4.5E+02	
Total Dissolved Solids	C010	7.1E+03		7.1E+03	
Total Kjeldahl Nitrogen (TKN)	C021	3.5E+00		3.5E+00	
Total Organic Carbon	C012	2.7E+01		2.7E+01	
Total Phosphorous	14265442	1.8E-01		1.8E-01	
Total Sulfide	18496258	2.6E+00		1.0E+00	U
Total Suspended Solids	C009	2.3E+01		1.0E+01	
Volatile Residue	C030	1.3E+03		1.3E+03	

Contaminant	CAS Number	Primary Treatment	Data Qualifier	Estimated Concentration Primary Treatment Plus Filter Media	Data Qualifier
Semivolatile Organics (ug/L)					
2,4-Dimethylphenol	105679	2.9E+01		1.0E+01	U
2-Methylnapthalene	91576	1.4E+01		1.0E+01	U
Acetophenone	98862	1.3E+01		1.0E+01	U
Benzoic Acid	65850	5.8E+01		5.0E+01	U
Benzyl Alcohol	100516	1.0E+01		1.0E+01	U
Dimethyl Phthalate	131113	1.2E+01		1.0E+01	U
Naphthalene	91203	1.4E+01		1.0E+01	U
N-Decane	124185	1.2E+01		1.0E+01	U
N-Docosane	629970	1.2E+01		1.0E+01	U
N-Dodecane	112403	3.3E+01		1.3E+01	
N-Eicosane	112958	2.8E+01		1.1E+01	
N-Hexadecane	544763	4.1E+01		1.6E+01	
N-Octadecane	593453	2.8E+01		1.1E+01	
N-Tetracosane	646311	1.2E+01		1.0E+01	U
N-Tetradecane	629594	2.0E+01		1.0E+01	U
O-Cresol	95487	1.1E+01		1.0E+01	U
Phenanthrene	85018	1.1E+01		1.0E+01	U
Phenol	108952	1.3E+01		1.0E+01	U
Volatile Organics (ug/L)					
m+p-Xylene	179601231	5.1E+01		1.0E+01	
2-Butanone	78933	5.1E+01		5.1E+01	
2-Propanone	67641	6.0E+01		6.0E+01	
4-Methyl-2-pentanone	108101	7.6E+01		7.6E+01	
Benzene	71432	2.5E+01		2.5E+01	
Carbon Disulfide	75150	1.0E+01		1.0E+01	
Ethylbenzene	100414	1.9E+01		1.9E+01	
o-Xylene	95476	4.0E+01		4.0E+01	
Toluene	108883	5.1E+01		5.1E+01	
Total Metals (ug/L)					
Aluminum	7429905	5.1E+01		5.1E+01	
Antimony	7440360	6.0E+00		6.0E+00	
Arsenic	7440382	1.3E+00		1.3E+00	
Barium	7440393	3.6E+01		3.6E+01	
Boron	7440428	1.7E+03		1.7E+03	
Calcium	7440702	1.2E+05		1.2E+05	
Iron	7439896	2.7E+02		1.1E+02	
Lead	7439921	9.1E+00		9.1E+00	
Magnesium	7439954	2.5E+05		2.5E+05	
Manganese	7439965	1.1E+02		1.1E+02	

Contaminant	CAS Number	Primary Treatment	Data Qualifier	Estimated Concentration Primary Treatment Plus Filter Media	Data Qualifier
Molybdenum	7439987	4.5E+00		4.5E+00	
Nickel	7440020	1.2E+02		8.9E+01	
Selenium	7782492	6.9E+00		6.9E+00	
Sodium	7440235	2.3E+06		2.3E+06	
Tin	7440315	9.2E+00		9.2E+00	
Zinc	7440666	4.8E+02		2.9E+02	

U – Not detected in waste stream

For additional information on the capabilities of filter media, NSWCCD conducted field testing of two filter media systems. The systems were on USS GONZALES (DDG 66) and USS ROSS (DDG 71). The testing was undertaken to evaluate the performance of filter media and its subsequent ability to improve the quality of the water discharged from the OWS.

Testing showed that although the filter media functioned to remove oil, it was not consistently effective at achieving oil concentrations of less than 15 ppm. In the more favorable of two cases, the oil concentration was less than 15 ppm in only 32 percent of the effluent samples taken. For the second test the filter media system was even less effective at obtaining concentrations below 15 ppm. Both tests demonstrated that the percentage of oil removed by the filter media system was closely related to the OWS influent oil concentration (specifically, the higher the levels of influent particulate, the less efficient the removal process) (Navy, 2001c).

Although the finding did not support filter media achieving the less than 15 ppm oil concentration sought, it was concluded that the filter media system did reduce the discharged oil concentrations below those of the gravity coalescer system alone.

Field Information

Field tests conducted on LSD 41 gravity coalescer effluent samples included pH, temperature, salinity, specific conductance, and free and total chlorine. The values for the gravity coalescer samples were used to represent the primary treatment plus filter media values because the addition of a secondary MPCD is not expected to change the values for these parameters (Table 8-11).

Table 8-11. Field Testing for LSD 41 Primary Treatment Plus Filter Media

Field Parameter	Values
pH	6.9
Temperature	16.1 °C
Salinity	7.4 ppt
Specific Conductance	13,000 µS/cm
Free Chlorine	0.04 mg/L
Total Chlorine	0.04 mg/L

Descriptive Information

Descriptive observations and tests were conducted on LSD 47 gravity coalescer effluent samples. The filter media MPCD was not sampled for the LSD 47 class; however, based on a review of the filter media results for the DDG 51 vessel groups, the change in color from primary treatment to primary treatment plus filter media went from black to dark gray. A similar degree of change was assumed to occur for the LSD 41 vessel group, when a filter media MPCD is used. Consequently, while primary treatment yields a yellow colored effluent, further treatment with a filter media MPCD is expected to yield a light yellow colored effluent. Similar extrapolations were made for floating material, odor, settleable materials, and turbidity/colloidal matter.

8.3.1.3 Discharge Generation Rates for Mass Loading

The use of a primary and secondary MPCD does not affect the generation rate of bilgewater; therefore, the baseline generation and annual volume data are used for the annual discharge volume for this MPCD treatment system. It is assumed that the volume change due to the removal of oil by other treatment devices is negligible. See Table 8-4, Section 8.1.1.3, for the baseline generation volumes.

8.4 PRIMARY TREATMENT PLUS MEMBRANE FILTRATION

This MPCD option involves the waste stream being processed by a primary treatment MPCD followed by the secondary treatment of membrane filtration. Primary treatment plus membrane filtration creates two waste streams: the aqueous fraction, which is discharged overboard, and the oil fraction, which is directed to the onboard waste oil holding tank. The characterization of the aqueous fraction is described below. The oil fraction is subject to CHT, treatment at a permitted facility, and applicable Federal, State, and local disposal regulations.

8.4.1 Characterization Data

Characterization data are comprised of physical parameters, chemical data, field data, and descriptive information. Each of these parameters is discussed below. See Section 8.1.1 for identification of possible bilgewater sources.

8.4.1.1 Physical Parameters

The physical parameters used for modeling purposes, as detailed in Section 8.1.1.1, are not affected by the addition of primary and secondary MPCDs. Table 8-12 reiterates the parameters identified for modeling purposes.

Table 8-12. Discharge Characteristics for LSD 41 – Primary Treatment Plus Membrane Filtration

Modeling Parameters	Values	
Option Group	Primary Treatment Plus Membrane Filtration Scenario 1	Primary Treatment Plus Membrane Filtration Scenario 2
Vertical (feet)	+2	+3.5
Transverse (feet)	-42	+42
Length (feet)	190	380
Diameter (inches)	2	2
Temperature (°C)	25	25
Salinity (ppt)	7.7	7.7
Flow (gpm)	10	10
Velocity (ft/sec)	1	1
Duration of Release Event (hr)	11.7	11.7
Time Between Release Events (hr)	44.5	44.5

Vertical – Approximate distance from waterline to discharge port (+, above, -, below)
Transverse – Distance from centerline to discharge port (+, port, -, starboard)
Length – Approximate distance from forward perpendicular to discharge port
Diameter – Diameter of discharge port
ppt – parts per thousand
gpm – gallons per minute
ft/sec – feet per second
hr – hour
°C – Degree Celsius

The formulas used to determine some of the values in the physical parameters section are presented in Appendix A.

8.4.1.2 Constituent Data, Classical Data, and Other Descriptors

Chemical Data

Samples from the ships were taken at three points: prior to primary treatment, following primary treatment, and then following the membrane filtration treatment device. A geometric mean concentration for samples following the secondary treatment was determined for each constituent. Samples that were excluded by the SCC based on their review of the analytical data as documented in the Sampling Episode Reports were not included in the final calculations. See Appendix F for constituent values.

Field Data

Field tests conducted on the LSD 47 gravity coalescer plus membrane filtration samples included pH, temperature, salinity, specific conductance, and free and total chlorine. For these field tests, the reported value was determined by calculating and average of all field measurements. Table 8-13 lists the values for each parameter.

Table 8-13. Field Testing for LSD 41 Primary Treatment Plus Membrane Filtration

Field Parameter	Values
pH	7.0
Temperature	25.6 °C
Salinity	6.5 ppt
Specific Conductance	11,000 µS/cm
Free Chlorine	<0.04 mg/L
Total Chlorine	<0.04 mg/L

Descriptive Information

Descriptive observations and tests were conducted on the MPCD gravity coalescer plus membrane filtration samples from the LSD 47. This information included observations or measurements of colloidal matter, color, floating material, foam, odor, scum, settleable materials, taste, total dissolved gases, and turbidity. For parameters based on observations (color and odor), the reported determinations were based upon these samples. For the parameters based on measurements, an average was used as the reported value except for the total dissolved gases parameter. For this parameter, the lowest DO value was reported in the profile report and used in the environmental effects analysis, because lower DO values are a greater environmental concern. Table 8-14 lists the values for the descriptive data.

Table 8-14. Descriptive Discharge Profile for LSD 41 – Primary Treatment Plus Membrane Filtration

Narrative Parameter	Field Observations
Color	Yellow, 69 Color Units
Foam	None observed in samples collected
Floating Materials	None observed in samples collected
Odor	Fuel/ Oil Smell
Scum	None observed in samples collected
Settleable Materials	None observed in samples collected
Total Dissolved Gases	DO 1.23 mg/L, no other gases were measured
Turbidity/Colloidal Matter	9.4 NTU/No

8.4.1.3 Discharge Generation Rates for Mass Loading

The use of primary and secondary MPCDs does not affect the generation rate of bilgewater; therefore, the baseline generation and annual volume data are used for the annual discharge volume for this MPCD treatment system. It is assumed that the volume change due to removal of oil by treatment device is negligible. See Table 8-4, Section 8.1.1.3 for the baseline generation volumes.

8.5 COLLECTION, HOLDING, AND TRANSFER WITHIN 12NM

CHT is the onboard collection, containment, and subsequent transfer of bilgewater to shore facilities or ship waste offload barges (SWOBs). CHT does not involve any treatment of raw bilgewater on board the generating vessel. CHT may require the installation of some shipboard equipment, such as piping or tanks, to provide additional holding capacity. This MPCD option results in no (zero) liquid discharge to surrounding waters within 12 nm.

8.5.1 Characterization Data

Characterization data are comprised of physical parameters, chemical data, field data, and descriptive information. Each of these parameters is discussed below. See Section 8.1.1 for identification of bilgewater sources. However, because this MPCD option results in no (zero) direct liquid discharge to surrounding waters within 12 nm, there is no characterization data to address.

8.5.1.1 Physical Parameters

This MPCD option results in no (zero) direct liquid discharge to surrounding waters within 12 nm; therefore, there are no discharge characteristics to consider.

8.5.1.2 Constituent Data, Classical Data, and Other Descriptors

Chemical Data

Because a waste stream is not directly discharged to surrounding waters within 12 nm for this MPCD option, there are no constituents to consider.

Field Information

Because a waste stream is not directly discharged to surrounding waters within 12 nm for this MPCD option, there are no field data to consider.

Descriptive Information

Because a waste stream is not directly discharged to surrounding waters within 12 nm for this MPCD option, there is no descriptive information to consider.

8.5.1.3 Discharge Generation Rates for Mass Loading

CHT results in no direct liquid discharge to surrounding waters within 12 nm. Therefore, the annual discharge volume is zero.

8.6 UNCERTAINTY AND DATA QUALITY FOR LSD 41 DISCHARGE

The sources and levels of uncertainty in bilgewater characterization data vary by discharge parameter. This subsection describes the uncertainty associated with physical parameters; constituent data, classical data, and other descriptors; and discharge generation rates.

8.6.1 Physical Parameters Uncertainty and Data Quality for LSD 41 Discharge

Schematic Data

The information provided for the physical parameters of LSD 41 discharge is based on process knowledge and the vessel specifications of the representative vessel. Certain physical parameter values used in this report, including representative vessel length, discharge port diameter, and distance from centerline to discharge port (transverse), are taken directly from vessel schematics. These parametric values do not vary among vessels in the class. Certain other parameters vary with load conditions. These condition-specific parameters include approximate distance from waterline to discharge port (vertical) and discharge method. The discharge was assumed to occur under full load conditions to facilitate a comparison of baseline and MPCD option performance. This assumption is supported by Navy expert knowledge of ship status, which indicated that when vessels are pierside they typically are loaded for deployment.

Modeling Data

One use of the discharge characterization information is to provide input data for modeling. Modeling is performed to determine plume dilution factors at the edge of a mixing zone. Modeling calculations involve various parameters that include discharge temperature, density (salinity), and vessel attributes related to bilgewater discharge, such as the distance from the discharge port to the waterline. The bilgewater temperature was assumed to be equal to ambient water temperature for modeling purposes. Bilgewater is stored in OWHTs in direct contact with the hull, resulting in temperature equilibration. The bilgewater data for salinity was taken from UNDS sampling data. Uncertainty related to sampling is discussed in Section 8.6.2 and applies to the salinity data.

As stated in Section 8.1.1.1, the discharge flow rate used to characterize the discharge is based on the rated capacity of the processor as reported by the manufacturer. The duration of, and time between release events, are closely related and are dependent on the volume of the OWHT. The volume of the OWHT at processing onset determines the duration of the release event. Likewise, the time between release events is related to the capacity of the OWHT and the bilgewater generation rate. A simplifying assumption, that the release of bilgewater discharge occurs when the OWHT reaches 90 percent of capacity, was made based on knowledge derived from equipment experts.

8.6.2 Constituent Data, Classical Data, and Other Descriptors Uncertainty and Data Quality for LSD 41 Discharge

Sampling was conducted aboard the LSD 47 and LSD 51 according to the SAP (Navy, 2000f and 2001e). Deviations in sampling practices, analytic testing, laboratory equipment, processing equipment, and specimen handling exist and may affect the results. For more information on the sampling plan, see the LSD 47 and LSD 51 SAPs.

During the sampling episode, deviations from the sampling plan were noted in the SER.

- Sampling deviations recorded on USS RUSHMORE (LSD 47) were due to the inability to sample while the ship was underway. All samples were collected while the vessel was in port. Consequently, the ceramic membrane permeate was directed to the waste oil tank (WOT) instead of being discharged overboard.
- A deviation from the SAP on USS OAK HILL (LSD 51) included the possible inadvertent discharge of oily waste overboard due to a malfunctioning OCM.
- On USS OAK HILL (LSD 51) strap-on ultrasonic flow meters were not used during sample collection. Tank indicators, system run time and pump capacity ratings were the sources of flow information.

The sampling episode report (SER) also details issues identified during the sample analysis, including the SCC's review of the analytical data. The SCC Data Review Narratives note the quality of the sample analysis data. The reports also contain further details regarding additional data qualifiers for specific constituents for the samples. A complete description of how qualified data were used in the UNDS program can be found in Section 8.1.1.2.

LSD 47 and LSD 51 sample data were used to characterize this vessel group. As described in the *Vessel Grouping and Representative Vessel Selection for Surfaced Vessel Bilgewater / Oil-Water Separator Discharge* (Navy and EPA, 2001a), although subsequent decision-making resulted in the selection of LSD 41 to represent this vessel group, process knowledge indicates that there are no significant differences in bilgewater composition between the vessels of the same class.

8.6.2.1 Discharge Generation Uncertainty and Data Quality for LSD 41 Discharge

Bilgewater generation rates for the LSD 41 vessel group used in this report to characterize the discharge are estimated based on process knowledge and previously reported values. The UNDS Phase I Surface Vessel Bilgewater/OWS Nature of Discharge Report (NOD) estimates that the average in-port generation rate for a LSD Class Vessel is approximately 2,000 gal/day (EPA and DoD, 1999). However based on actual performance data, the generation is typically 2,500 gal/day in port and 10,000 gal/day underway (Navy, 1997a). Additionally, this vessel group is comprised of vessels varying in vessel size, machinery, and displacement. As a result, having multiple vessel classes in the group results in variation in generation rates and adds uncertainty to these values.

The addition of primary treatment and secondary treatment MPCDs does not affect the annual generation rates for mass loading. As a result, the uncertainty identified here applies to all MPCD options.